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An experimental evaluation of a group- versus computer-based intervention to improve food portion size estimation skills

Guadalupe Xochitl Ayala[1,2]

[1]Department of Health Behavior and Health Education, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599-7440, USA

Abstract

The ability to accurately estimate and measure food portion sizes is important for preventing and treating obesity. This study describes the development, implementation and evaluation of a group-versus computer-based intervention to improve food portion estimation abilities using real food and food models. A convenience sample of 76 women was randomly assigned to one of three conditions: computer training, group training or a waitlist control condition. Assessments at baseline and 2 weeks post-intervention included portion size testing using real foods and food models, self-efficacy for judging portion sizes and using measuring utensils, and knowledge of portion information. At baseline, greater estimation errors were observed for amorphous foods. No group by time interaction was observed on estimation of real foods; however, both the computer and group training resulted in significant improvements in estimating the size of food models, greater self-efficacy for judging portion sizes and more accurate knowledge of portion information compared with the control condition. Process measures indicated that the group training was deemed more helpful and more personally relevant to the participants.

Introduction

The epidemic of obesity is attributable to an imbalance of energy intake and energy expenditure (Stubbs and Lee, 2004). Increases in energy intake are due, in part, to increases in food portion sizes (Hill and Peters, 1998; French *et al*., 2001; Young and Nestle, 2002). Restaurant portion sizes have increased dramatically (Nestle and Jacobsen, 2000) and food portions exceed standard portions by as much as 700% [e.g. chocolate chip cookies (Young and Nestle, 2002)]. In several controlled laboratory studies, when larger portions were presented, a corresponding increase in energy intake was observed (Rolls *et al*., 2002, 2004). Portion sizes and their various reference points (small, medium and large) have become subjective interpretations of food quantity, and no longer carry an objective quantifiable standard (Guthrie, 1984; Smith *et al*., 1991; Young and Nestle, 1995). Interventions to improve food portion estimation skills are clearly needed.

Food portion estimation interventions

Interventions to improve food portion estimation abilities have manipulated and/or examined the following elements: *type of measurement aid used in training* [food models and household measuring tools equally improved estimation abilities compared with a no-

[2]Correspondence to: G. X. Ayala; gxayala@email.unc.edu.

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treatment control condition (Bolland *et al.*, 1988), measurement of solid foods improved when using measuring cups (Weber *et al.*, 1997), and two- and three-dimensional practical measurement aids improved estimation abilities (Byrd-Bredbenner and Schwartz, 2004)], *container size* [estimation errors greater for amorphous foods measured in large versus small containers (Yuhas *et al.*, 1989)], *food type* [amorphous foods less accurately estimated than solid foods (Rapp *et al.*, 1986; Yuhas *et al.*, 1989; Howat *et al.*, 1994; Slawson and Eck, 1997) and larger improvements were observed for amorphous foods (Weber *et al.*, 1997)] and *type of assessment* [fewer errors observed when food photos used by the treatment group (Howat *et al.*, 1994)]. Limitations of this research, however, are the use of college students in nutrition classrooms (Bolland *et al.*, 1988; Yuhas *et al.*, 1989; Slawson and Eck, 1997) and lack of a control condition (Slawson and Eck, 1997; Byrd-Bredbenner and Schwartz, 2004). In addition, some researchers have failed to find interventions effects. For example, after delivering a 1-hour group-based intervention using food models and life-size food photographs, Howat *et al.* (Howat *et al.*, 1994) found no training effects on estimation abilities using food models. Yuhas *et al.* (Yuhas *et al.*, 1989) found no sustained accuracy in estimation abilities 4 weeks after the intervention.

Present study

Improving food portion estimation abilities is important for preventing and treating obesity. The present study represents a randomized controlled experiment testing the efficacy of two theoretically driven interventions (computer- and group-based) to improve food portion estimation abilities compared with a waitlist control condition. This study builds upon past research in a number of ways. First, it sought to improve food portion estimation abilities in a community sample. Most research to-date has been conducted with a college student population. Second, it compared two treatment conditions with a control condition, a notable limitation of previous research. Third, the computer was used as one intervention modality to examine the feasibility and efficacy of delivering food portion estimation training via a channel that over the long run may require less resources to deliver once developed, compared with the on-going costs associated with group training. Finally, unlike previous research in which estimation skills were the only outcome of interest, this study examined potential mediators of change (i.e. self-efficacy and knowledge) to identify intervention targets for future research.

Methods

Study design

This study was a three-group randomized controlled experiment with two measurement periods (baseline and immediate post-intervention). The baseline measurement protocol consisted of portion size testing using real foods and food models, measurement of height and weight, an interviewer-administered survey, and one 24-hour dietary recall and two food records (recalls and food records not reported in this paper). The experimental conditions included a 1-hour computer-based training session, a 1-hour group-based training session and a waitlist control condition. Two weeks post-intervention the participants completed the second measurement protocol which paralleled the baseline protocol. All participants received a movie ticket after completing the baseline interview and US$10 at post-intervention.

Recruitment

Following Institutional Review Board approval, flyers, newspaper advertisements and web-based bulletin board announcements were placed throughout the county. The recruitment materials provided study and contact information, and research assistants (RAs) used a standard protocol when responding to inquiries. The primary inclusion criterion was gender;

we only included women in this study given gender differences in visual–spatial abilities. Interested women were screened for other inclusion (at least 18 years of age and planning to remain in the area for 1.5 months) and exclusion criteria (on a special diet or have an eating problem). If the woman met eligibility criteria, she was assigned an identification number and the baseline interview scheduled. Women who did not meet eligibility criteria because they were too young or planning to leave the area were thanked for their time and referred to several outlets for nutrition information. Women who did not meet eligibility criteria because of a special diet or eating problems were referred to the Center for Eating and Weight Disorders.

Eighty-nine women were screened for participation in the study. Six women did not meet eligibility criteria (four on a special diet/eating problems and two leaving town). Eighty-three women were recruited to participate in the study, 76 women completed the baseline assessment (seven women cancelled repeatedly) and 67 (88% of baseline) completed the post-intervention assessment. Among the nine women who did not complete the post-intervention assessment, two were determined to be ineligible due to language barriers and seven women refused to continue participating after intervention delivery (four in computer, two in group and one in waitlist).

Participants

The convenience sample of 76 women ranged in age from 19 to 79 years ($M = 37.53$; SD = 15.29). An equal number of women were either currently married (39.5%) or never married (39.5%). Over half of the women were employed full-time (48.7%) or part-time (25%) outside the home and the median household income was ≥US$3501/month (41%). Most of the women reported White/Caucasian ethnicity (58%). The majority were born (84.2%) and educated in the US (92.1%; mean years of education = 17.04; SD = 2.71). Self-rated health was average in this sample ($M = 2.36$; SD = 0.93; ‘1’ = excellent to ‘5’ = poor). Mean body mass index (BMI) was in the overweight range ($M = 26$, SD = 5.19), with participants’ BMIs ranging from 18 to 45. The prevalences of overweight and obesity in this sample were 29.7% and 20.3%, respectively (see Table I).

Intervention development and delivery

The modes of intervention delivery selected for this study were based on two factors: ease of delivery (e.g. cost, transportability to a large intervention) and participant receptivity. On a continuum of ease of delivery, group and computer interventions fall at opposite ends (Glasgow *et al.*, 2001). Group interventions require substantial personnel, material and space resources (Campbell *et al.*, 2001). Participants must agree to meet at the same time and in the same location. Computer interventions, however, require fewer on-going material and space resources. Generating the computer program costs more initially and delivery requires access to a computer; although, after initial expenditures associated with development and testing, very little maintenance is required (Glasgow *et al.*, 2001).

Participant receptivity is important for cohort maintenance and can have an impact on the efficacy of an intervention (Flay, 1986). If an intervention is well received, participants are likely to remain in the study for a longer period of time. Similarly, interventions that are designed to meet the needs of the participant will catch the attention of the participant and will more likely bring about change (De Vries and Brug, 1999). With the advent of computer technology, receptivity to computerized interventions has become an important issue. A number of computerized interventions measuring constructs and behaviors other than knowledge have been documented in the literature (Burnett *et al.*, 1989; Bartholomew *et al.*, 2000; Carlton *et al.*, 2000; Evans *et al.*, 2000). In addition, many tailored communication interventions involve computer interactivity (Kreuter *et al.*, 1999). The former literature suggests that participants are able to attend to computerized tasks despite ambient noise (Bartholomew *et al.*, 2000) and prefer information with a behavioral focus (Carlton *et al.*, 2000).

Despite differences in modality, the interventions used in this study were linked by a common theoretical framework. Development of the intervention components was based on Social Cognitive Theory (Bandura, 1986) and Behavior Analysis (Baer *et al.*, 1968). Constructs central to this intervention included self-efficacy, modeling, shaping, feedback and goal setting. Self-efficacy for improving portion size estimation skills was targeted through the provision of information as well as skill development through modeling and shaping of the behavior. Participants manipulated materials, received feedback on successive approximations of the behavior, and learned from both role models and similar others. Role models provided examples of skill mastery, whereas observing similar others provided a basis for social comparison (Bandura, 1986). Participants were also instructed to set goals following the intervention, and encouraged to engage in stimulus, response and interpersonal generalization of learned behavior.

The group and computer interventions were designed to be as similar as possible: 1 hour in length, delivered during a single session and identical curriculum. However, the modes of delivery introduced some variation. The primary differences between the two modes of intervention were the level of interactivity with materials and the opportunity to receive feedback from other participants. Group participants physically manipulated measuring utensils and food models, whereas computer participants were only allowed to see these items in two- and three-dimensional forms (i.e. pictures and videos). Group participants were allowed to interact with other group members, learn from their mistakes and copy behaviors that were deemed masterful. Computer participants were only provided modeling delivered by an instructor. Two additional differences included the order of intervention content (constant for group participants; computer participants not restricted to view information in a set order) and pace of intervention delivery (constant for group participants; computer participants set their own pace).

Women assigned to the group and computer conditions were called within 1 week of completing the baseline assessment to either attend the next group meeting or to complete the computer program. A total of eight groups were held over the intervention period. The groups ranged in size from two to four individuals, with a median of three women per group. Women in the computer condition participated in the intervention alone in front of a laptop computer with the CD-ROM program.

The intervention curriculum was divided into four sections. Section 1 included information about the importance of portion sizes in weight control and chronic disease prevention using pictures and text. Section 2 included information from the food guide pyramid on recommended portion sizes for each food group and information from the ‘Nutrition Facts’ label. Sections 3 and 4 contained the primary skill development material. Participants were instructed how to use various parts of their hand to represent portion sizes. In the group condition, women compared the size of their hand with each other, the group leader and various food models. In the computer condition, this information was presented visually using photographs of a woman’s hand and various food models. Women in the computer condition were instructed to look at their own hands and compare them with the model in the picture. Participants in both conditions were then provided information on common household items that could be used to estimate portion sizes (e.g. a CD case = one slice of bread). Group participants were shown and encouraged to manipulate and compare household items with food models. Computer participants were shown numerous pictures depicting these images. At the end of this section, women brought this information together by comparing measurement using one's hand, measuring utensils, household items and food models.

Following presentation of this information, women measured out liquids, solid foods and amorphous foods with immediate and delayed feedback. The complexity of the measurement task increased with each practice. Group participants performed this task using actual materials. In the computer condition, several videos were presented to the participant depicting the skills, with the opportunity to estimate portions and receive immediate or delayed feedback on estimation abilities. At the conclusion of the intervention, participants were asked to identify a behavioral goal and an intermediary target behavior link to the goal. Participants received a set of handouts to take home.

Measurement procedures and materials

Our measurement protocol at baseline and post-intervention included portion size testing using real foods and food models, measurement of height and weight, and a 1.5-hour interviewer-administered survey.

Portion size testing—The main outcome of interest, food portion estimation abilities, was operationalized two ways: measurement of 13 real foods and estimation of 14 food models (see Tables II and III for listing of foods and food models). Selection of the foods for portion size testing was based on the following: real foods and food models representing liquids, solids and amorphous foods; real food and food models representing healthy and less healthy foods; availability of food as a food model to allow for comparability with real food estimation skills; and ease of storage and handling. We were unable to find a food model to represent oil and, during pilot testing, we determined that participants did not want to measure out fresh meat.

The first portion size test assessed the participant's accuracy in measuring out a proscribed amount of 13 different real foods. Presentation of the food items and all instructions were standardized across all participants. Participants were asked to serve a specified portion of 13 different foods on pre-weighed 8-inch plastic-wrapped dinner plates or 12 oz plastic tumblers. The plates and tumblers with the measured foods were individually placed on the scale and weighed to the nearest 0.1 g (Ohaus portable electronic scale; CS2000). Solid foods included 1 Tbs butter, 1/2 cup cooked rice, 1/2 cup green beans, 1 cup popcorn and a 2 × 2 inch brownie. Liquids included 4 oz apple juice, 12 oz soda, 1 Tbs liquid oil and 8 oz 2% milk. Amorphous foods included 1 Tbs jam, 1 Tbs mayonnaise, 1/2 cup apple sauce and 1/2 cup pudding.

The dependent measure of interest was the absolute value of the percent error in estimation, with error reflected in the weight difference between the estimated quantity and the actual quantity based on pre-testing. The standard approach to calculating percent error of estimation uses the following equation (Chambers *et al.*, 1999): absolute value of: [(estimated quantity − actual quantity)/actual quantity] × 100.

The measure of actual quantity for each food in the real food portion size test was based on extensive preliminary testing of food weight on material identical to the testing procedure. Three RAs measured out exact portions of each food on an 8-inch plate covered with plastic wrap. The foods were weighed, material weight was subtracted and an actual quantity score was computed for each food. Inter-rater agreement scores in the high 90s suggested that the weight obtained from the gold standard reliably represented the actual weight. The absolute value of the percent error of estimation was computed for each food tested, for a total of 13 dependent variables.

The second portion size test consisted of participants rating the quantity or size of 14 food models purchased from the NASCO company. Participants were instructed to write down their estimation on the last page of the survey. For each food model, participants received a score of ‘1’ for providing the correct size/quantity and ‘0’ for providing the incorrect size, and ultimately a total score for number of food models correctly estimated. Solid foods included 1 Tbs butter, 1/2 cup cooked rice, 1/2 cup green beans, 1 cup popcorn, a 2 × 2 inch brownie, 3 oz chicken thigh and 3 oz hamburger patty. Liquids included 4 oz apple juice, 12 oz soda and 8 oz 2% milk. Amorphous foods included 1 Tbs jam, 1 Tbs mayonnaise, 1/2 cup applesauce and 1/2 cup pudding.

Anthropometry—Weight was measured to the nearest 0.25 lb using a standard scale (Seca 840 digital floor scale) and standard protocol (e.g. removal of heavy objects from pockets). Height was measured to the nearest 0.25 inch following standard measurement of height using a stadiometer [Seca 214 portable stadiometer (Simko *et al.*, 1995)]. Three measures of weight and height were obtained alternatively from each participant, and used to calculate the BMI—a convenient and reliable indicator of obesity (Garrow and Webster, 1985).

Interview—self-efficacy—Our secondary outcome of interest was self-efficacy. A scale was developed measuring three aspects of self-efficacy specific to this behavior: confidence in judging portion sizes across different situations (‘judging portion sizes’), confidence using measuring utensils (‘measuring utensils’) and confidence measuring ingredients (‘measuring ingredients’). The scale was adapted from an instrument developed by Ounpuu *et al.* (Ounpuu *et al.*, 1999) measuring self-efficacy for changing a high-fat diet. The current scale consisted of 16 items with response options ranging from ‘1’ (not at all confident) to ‘5’ (very confident).

Principal component factor analysis using varimax rotation was performed on the scale. The eigenvalues for the three factors ranged from 1.24 to 7.19 and explained 65% of the variance. Factor loading on each item ranged from 0.58 to 0.95. The average loading was 0.75, demonstrating very good unification (Tabachnick and Fidell, 1996). Internal consistency analyses using Cronbach’s coefficient α yielded αs of 0.92 on the ‘judging portion sizes’ and ‘measuring utensils’ subscales, and 0.65 on the measuring ingredients subscale. Based on these findings, mean confidence scores were computed for the ‘judging portion sizes’ subscale (11 items) and the ‘measuring utensils’ subscale (two items) only.

Interview—knowledge of portion size information—Participants were assessed on their knowledge of portion size information on nutrition labels, the food guide pyramid and household measurement aids using 15 items developed for this project. Response options included true/false, multiple choice and fill-in-the-blank. A knowledge score was computed for each participant by recoding responses either correct (‘1’) or incorrect (‘0’) and then summing across all questions for a total possible score of 15.

Interview—impressions of portion sizes—Two questions assessed perceptions of changes in home and restaurant portion sizes over a 5-year period. Responses included: smaller, larger or about the same as 5 years ago. A change score was computed such that ‘1’ = change in expected direction (e.g. from ‘about the same’ to ‘larger’), ‘0’ = no change and ‘−1’ = change in opposite direction (e.g. from ‘about the same’ to ‘smaller’).

Interview—demographic information—Standard demographic information was collected from the women (see Table I). Women were also asked to rate their perceived health status from ‘1’ = excellent to ‘5’ = poor using a single question.

Interview at post-intervention—process evaluation—At post-intervention, women in the computer and group conditions rated their level of satisfaction with the intervention on several open- and close-ended questions.

Results

Consistent with the objectives of random assignment, no differences were observed between the groups at baseline. Demographic, health and dietary data were also examined for systematic differences between refusers (participants who dropped out of the study) and completers. There were no differences between refusers and completers on age, ethnicity, self-reported health, BMI, self-efficacy, knowledge of portion information and portion size estimation abilities. Differences that were significant or approached significance included education (refusers were less educated than non-refusers; $P \leq 0.05$) and income (refusers had lower income levels than non-refusers; $P = 0.10$).

Repeated measures MANOVA were used to examine changes in the absolute value of the percent error in estimation for the 13 real food portion size tests. This approach is also known as a doubly multivariate repeated measures design and can be applied with unbalanced designs using Type III sum of squares (i.e. unequal cell sizes). The overall test of the intervention on the 13 portion size tests was not significant at the 95% confidence level [Wilks' $\lambda = 0.519$, $F_{(26,88)} = 1.312$, $P = 0.175$, effect size (ES) = 0.28]. In other words, there was no group by time interaction on portion size estimation abilities. An examination of the univariate tests for each food, using Greenhouse–Geisser corrections for violations in the assumption of sphericity, revealed significant group by time interactions for two portion size tests: green beans ($P \leq 0.05$) and pudding ($P \leq 0.05$). Participants in the waitlist control condition improved their estimation of green beans, but made greater estimation errors on pudding. A main effect was observed for time (Wilks' $\lambda = 0.644$, $F = 1.867$, $P \leq 0.05$, ES = 0.34). This finding was driven by significant changes in the estimation of rice, brownies, apple juice and milk (see Table II).

The second portion size test assessed the change in number of accurately estimated food models by intervention group from among 14 food models. At baseline, participants in all three conditions accurately estimated the size of more than half of the food models. Nevertheless a group by time interaction was observed (Wilks' $\lambda = 0.848$, $F_{(2,64)} = 5.76$, $P \leq 0.01$; ES = 0.152). Participants in the group condition accurately estimated more of the food models ($M = 10.18$, SD = 2.58), followed by the computer condition ($M = 9.43$, SD = 2.44). A drop in accuracy was observed among participants in the waitlist control condition ($M = 8.71$, SD = 3.00).

Using χ^2-tests, significant differences were observed on the percent of incorrect estimations by intervention group at post intervention. A larger percentage of waitlist control condition participants incorrectly estimated the size of green beans ($P \leq 0.05$), popcorn ($P \leq 0.01$), chicken thigh ($P \leq 0.05$) and mayonnaise ($P \leq 0.01$), compared with participants in the group and computer conditions. However, a larger percentage of participants in the group condition incorrectly estimated jam ($P \leq 0.05$), and a larger percentage of participants in the computer condition incorrectly estimated milk ($P \leq 0.05$) and pudding ($P \leq 0.05$) (see Table III).

Repeated measures ANOVA were used to examine intervention effects on the two self-efficacy subscales. A group by time interaction was observed for confidence in judging portion sizes (Wilks' $\lambda = 0.85$, $F_{(2,64)} = 5.55$, $P < 0.01$; ES = 0.15) (see Table IV). No significant interaction or main effect was observed in self-efficacy for using measuring utensils.

Participants responded to 15 questions regarding their knowledge of portion size information on food labels, the food guide pyramid and household measurement aids. The group by time interaction approached significance (Wilks' $\lambda = 0.916$, $F_{(2,63)} = 2.872$, $P \leq 0.064$). However, the overall ES was very small (0.084). There was a trend to suggest greater improvements in knowledge in the group condition (baseline $M = 9.27$, SD = 2.19 to post $M = 10.64$, SD = 1.87) compared with the computer condition ($M = 8.48$, SD = 2.40 to $M = 8.67$, SD = 2.78) and waitlist control condition ($M = 9.00$, SD = 2.65 to $M = 9.22$, SD = 2.63).

Participants were asked about their impression of food portion sizes served at restaurants and consumed at home compared with 5 years ago. At baseline, a majority (57%) of participants reported that they thought the portion sizes at restaurants were larger. Portion sizes consumed at home were deemed about the same by 60% of participants. Following the intervention, a greater number of computer participants (35%) as compared with group (9%) or control (4%) participants were found to change their impressions of restaurant portion sizes in the expected direction ($\chi^2 = 9.26$, $P \leq 0.05$). Similar findings were observed in response to change in home portion sizes (computer: 33%; group: 9% and control: 4%; $\chi^2 = 9.38$, $P \leq 0.05$).

Process evaluation

Few group differences were observed on our process evaluation questions. Women in the group condition reported stronger agreement that the intervention information was more relevant to their lives compared with women in the computer condition (group: $M = 3.05$, SD = 0.59; computer: $M = 2.45$, SD = 0.89; $P < 0.05$). Group condition women also reported stronger agreement that the intervention information was helpful (group: $M = 2.67$, SD = 0.58; computer: $M = 2.30$, SD = 0.80; $P \leq 0.01$) (see Table V).

On the open-ended questions, women reported enjoying measuring out and comparing portion sizes, learning how to use everyday household items to estimate quantities, learning to use one's hand to estimate quantities, learning about the food guide pyramid, and the use of a video to demonstrate skills. The primary complaints were the speed of intervention delivery (two said too fast), delivery of intervention by computer ($n = 5$) and use of household items to estimate quantities ($n = 4$). Interesting generalizations of the intervention were observed across both conditions. In addition to greater awareness and attempts to modify food portions at home ($n = 25$), many women acknowledge eating more fruit ($n = 6$). Several women reported awareness of the 5-a-day campaign and their erroneous assumption that they were meeting the 5-day goal until they assessed the actual portions of fruits and vegetables consumed. Stimulus generalizations included using skills in a restaurant ($n = 6$) and in the grocery store ($n = 3$, i.e. purchasing meat). Finally, several women reported that they stopped seeing a meal as a portion and instead attempted to estimate the number of actual portions of each food group in a given meal.

During their participation in the intervention, women were asked to identify a take-home goal. Results from this goal setting exercise provide additional evidence of generalization of the skills. Ten women set the goal of using the skills at a restaurant or social event. Twelve women agreed to eat more fruits and vegetables, and one woman agreed to consume more calcium. Several women stated that they would ask their butcher to cut the meat into smaller portions.

Discussion

This study tested two modes of a brief intervention to improve real food and food model portion estimation abilities compared with a waitlist control condition. Secondary outcomes included self-efficacy and knowledge of portion size information. Multivariate analyses revealed no group by time interaction on real food portion estimation abilities at post-intervention. However, a main effect of time was observed for estimation of real foods. The failure to find group by time intervention effects on real food estimation abilities is consistent with a previous study (Howat *et al.*, 1994) and may be attributed to the large within-subject error associated with dietary assessment (Willett, 1998). The ability to detect between-subject differences is directly proportional to within-subject error variance. Although the power of the test was acceptable (0.89), larger sample sizes may be needed to account for the within-subject error. Consistent with this explanation were the observed intervention effects on the food model portion test and secondary outcomes. Specifically, participants in the group and computer-based conditions reported improvements in their ability to estimate the size of 14 food models, were more confident in judging portion sizes, and were more knowledgeable about portion size information. All three outcomes variables were measured on scales that minimized the possibility of large sources of within-subject error variance. The underestimation findings may also be due to a heightening of the 'Hawthorne Effect' (Rosenthal and Rosnow, 1991). Participants in this study became aware of the importance of portion sizes following the first assessment protocol and after participating in the intervention. It is possible that women in this study overcompensated by underestimating food portion sizes.

Estimation errors were very high compared with previous research particularly for solid foods such as popcorn and amorphous foods such as mayonnaise. Although Young and Nestle (Young and Nestle, 1995) argued that participants are no more likely to make estimation errors on amorphous foods, these findings do not support this conclusion. Overall, amorphous foods were underestimated to a greater extent compared with liquid and solid foods.

Limitations

There are a number of limitations associated with this study. Assessing participants on their ability to estimate portion sizes requires a complex set of instructions that are delivered to the participant in a clear and consistent manner. The RAs were trained extensively, blinded to condition and prompted to use specific instructions by including the protocol on the first page of survey. Nevertheless, without a second RA present there is no guarantee that each of the participants received the same set of instructions. Similarly, participants in both intervention conditions were made aware that portion sizes available in restaurants and prepackaged foods have increased dramatically. This information may have introduced demand characteristics during the assessment process. Second, Perry (Perry, 1999) and others (Baranowski *et al.*, 1997) have argued for conceptualizing and designing interventions that include the mediating factor that may explain intervention effects on the outcomes of interest. In this study, self-efficacy was hypothesized to mediate the relationship between the intervention and the portion size tests. Although the mediational model was not tested because no intervention effects were found, our findings on self-efficacy are further limited by the introduction of a new scale without established psychometric properties. The extent to which these subscales were valid measures of the construct has yet to be determined. Finally, participants in this study were not randomly sampled from the target population and thus may not generalize to the larger population. The women were fairly young and more than half were not married. The mean level of education was very high (college graduate), as was the monthly income. In addition, although attrition was low, the women who dropped out of the study were less educated and reported less income than women who stayed in the study.

Implications for future research

In our process evaluation, we found that some participants preferred to use instruments that provided quantitative information (e.g. use of measuring cups and scales), whereas others preferred less specific information. This is similar to work by Subar *et al.* (Subar *et al.*, 1995). These differences may be associated with differences in need for cognition as outlined in the Elaboration Likelihood Model (Petty and Cacioppo, 1986). Future studies should consider examining this construct within the context of a tailored intervention.

The present study targeted individual skill development. A potentially more important line of research would involve changing environmental influences on dietary behaviors (Swinburn *et al.*, 1999; US Department of Health and Human Services, 2000; Dietz and Gortmaker, 2001; Jeffery, 2001; Kumanyika, 2001). Environmental factors that contribute to obesity include the availability of large quantities of food, and the tendency for restaurants and other food establishments to promote large servings (Hill and Peters, 1998; Harnack *et al.*, 2000). Intervention strategies targeting the environment are needed at all levels from qualitative research (e.g. public opinion studies) to policy intervention (Booth *et al.*, 2001). The fact that most participants in this study failed to recognize a change in portion sizes served in restaurants suggests that consumers are unaware of what is happening in their environment. Would it be possible to incrementally decrease the size of food portions served in restaurants and packaged in grocery stores without a corresponding consumer outcry? ‘Silent’ interventions, i.e. interventions conducted at the environmental level without informing the consumer, have been successful in altering food preparation techniques to decrease fat consumption (Swinburn *et al.*, 1999). Structural models such as those proposed by Elder *et al.* (Elder *et al.*, 2002), Cohen *et al.* (Cohen *et al.*, 2000) and Swinburn *et al.* (Swinburn *et al.*, 1999) suggest approaches for altering the environment without intervening at the individual level. Policy interventions similar to those targeting the tobacco industry are clearer needed (Nestle and Jacobsen, 2000).

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Table I

Participant demographic and health characteristics

		n
Mean age (SD)	37.53 (15.29)	76
Marital status (%)		
married	39.5	30
never been married	39.5	30
divorced or separated	21.0	16
With children in the home (%)	38.2	29
median no. of children	1.00	
Mean years of education (SD)	17.04 (2.71)	76
Country of education (%)		
US	92.1	70
other	7.9	6
Employment status (%)		
employed full-time	48.7	37
employed part-time	25.0	19
self-employed	2.6	2
retired	7.9	6
currently not employed	15.8	12
Monthly household income [US$ (%)]		
≥1500	14.4	11
1501–2500	19.7	15
2501–3500	18.4	14
≥3501	41.0	31
refused or did not know	6.5	5
Ethnicity (%)		
White/Caucasian	58.0	44
Latina/Hispanic	15.8	12
other ethnicity	26.2	20
Generation status (%)		
first generation	15.8	12
second generation	28.9	22
third generation	9.2	7
fourth generation	15.8	12
fifth generation	30.3	23
Mean number of years (SD)		
first generation	23.50 (13.87)	12
all other generations	35.29 (15.43)	64
Self-rated health[a]	2.36 (0.93)	76
BMI[b]	26.00 (5.19)	76

[a]Self-rated health measured on a scale from ‘1’ = excellent to ‘5’ = poor.

[b]Fifty percent of the women were in the healthy weight range (18.6–24.9), 29.7% were in the overweight range (25.0–29.9) and 20.3% were in the obesity range (30.0–39.9).

Table II

Mean percent errors of estimation (absolute values) at baseline and post-intervention by group and type of real food estimated[a]

	Computer		Group		Waitlist	
	Base	**Post**	**Base**	**Post**	**Base**	**Post**
Solid foods						
butter	43.33	33.33	32.86	32.50	41.96	35.12
rice	25.92	31.80	22.10	33.22	21.44	21.98
green beans*	29.99	27.59	17.68	25.09	33.99	22.82
popcorn	59.51	60.49	66.30	61.85	92.59	71.60
brownie	33.70	24.81	33.75	24.86	35.88	28.70
Liquids						
apple juice	32.86	26.33	29.51	18.48	22.62	20.60
soda	17.91	16.71	11.58	15.20	12.92	14.64
oil	29.09	36.97	44.55	48.64	49.62	42.05
milk	19.40	21.28	22.37	28.69	12.73	14.87
Amorphous foods						
jam	28.86	27.57	30.68	36.71	31.79	31.96
mayonnaise	68.02	68.97	74.90	42.78	68.95	57.96
apple sauce	40.79	42.11	44.22	43.99	38.07	42.35
pudding*	40.39	40.61	45.17	43.01	36.97	46.72

[a] Wilks' $\lambda = 0.519$, $F_{(26,88)} = 1.312$, $P = 0.175$, ES = 0.28.

[*] $P < 0.05$.

Table III

Intervention effects on 14 food model portion size tests

	Computer	Group	Waitlist
Mean correctly estimated food models at baseline (SD)	8.19 (2.31)	8.23 (2.18)	9.13 (2.66)
Mean correctly estimated food models at post (SD)[a]	9.43 (2.44)	10.18 (2.58)	8.71 (3.00)
Incorrect estimation at post-intervention (%)			
solid			
butter	24	14	25
rice	62	59	63
green beans	19	5	38*
popcorn	38	23	67**
brownie	12	29	30
chicken thigh	19	18	46*
hamburger patty	52	36	63
liquids			
apple juice	33	32	26
soda	24	18	8
milk	38	23	8*
amorphous			
jam	10	41	29*
mayonnaise	5	27	46**
apple sauce	38	27	42
pudding	67	27	33*

[a]Wilks' $\lambda = 0.848$, $F_{(2,64)} = 5.76$, $P < 0.01$.

*$P < 0.05$;

**$P < 0.01$.

Table IV

Mean (SD) self-efficacy score at baseline and post-intervention by intervention group[a]

	Computer		Group		Waitlist	
	Baseline	**Post**	**Baseline**	**Post**	**Baseline**	**Post**
Confidence in judging portion sizes[a,b]	2.69 (0.67)	3.10 (0.60)	2.83 (0.96)	3.21 (0.87)	3.01 (0.62)	2.88 (0.78)
Confidence in using measuring utensils[b]	4.62 (0.65)	4.69 (0.56)	4.77 (0.46)	4.95 (0.21)	4.83 (0.35)	4.85 (0.38)

[a]Wilks' $\lambda = 0.85$, $F_{(2,64)} = 5.55$, $P < 0.01$.

[b]Response options ranged from '1' = not at all confident to '5' = very confident.

Table V

Process evaluation by intervention group status

	Computer		Group	
	Mean	**(SD)**	**Mean**	**(SD)**
How much did you trust the information?[a]	3.30	(0.66)	3.29	(0.64)
How much did information catch your attention?[a]	2.80	(1.01)	2.95	(0.74)
How easy was information to understand?[a]	3.35	(0.67)	3.48	(0.51)
How helpful was information?[a]	2.30	(0.80)	2.67	(0.58)**
How much did the information apply to your life?[a]	2.45	(0.89)	3.05	(0.59)*
How much effort did you apply to change process?[b]	6.35	(2.37)	5.57	(2.06)
Intervention length (%)				
too short	35		14	
too long	10		5	
the right length	55		81	
Kept materials (% yes)	100		100	
Share materials with others (% yes)	55		72	

* $P < 0.05$;

** $P < 0.01$.

[a] Response options ranged from ‘0’ = not at all to ‘4’ = completely.

[b] Response option ranged from ‘0’ = no effort to ‘10’ = a lot of effort.